CLEAN ENERGY FROM MUNICIPAL WASTE

" The environmental advantages of the controlled combustion of municipal wastes as sources of energy".

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ABSTRACT

This paper reviews the incinerator technology commonly employed in large municipalities prior to 1970 (the introduction of EPA regulation; and, more specifically the Clean Air Act of 1971); then, revisits the same technology as it could be applied in the 1990's, but with...an environmentally aware public, a vastly modified waste stream, the effects of recycling, controlled collection procedures, and the latest technology (being developed and/or imported from Europe).

In so doing, the review addresses: solid waste incineration prior to regulation (pre-1970); the experiences in introducing regulation (1970-1990); and, the significant environmental advantages in applying the latest knowledge, methodology, and technology to the reduction of municipal wastes by combustion, producing energies with a minimum adverse impact on the environment.

The delicate balances among the exposures (air, groundwater, land misuse), factors not properly addressed in the early stages of environmental control implementation are analyzed; and, scenarios are developed showing the overall environmental advantages when a portion of (up to 10-15%) solid waste as a fuel, replaces fossil fuels as a basic source.

PRECIS

The accumulation of solid wastes and the disposal of same had evolved into fairly well established procedures by the 1960's. In most of the highly developed countries of the world (Western Europe, North America, and the Pacific rim) solid waste was collected and disposed of under controlled conditions. Actually, population density determined the options to be selected by the local communities.

Except to when collection procedures affect the disposal system (such as in recycling), said procedures will not be developed hereinafter. Accordingly, the emphasis will be in the disposal of solid wastes in areas of the denser populations. This will represent an estimated 90% of the solid waste of approximately 90% of the populations. The comparison of these disposal procedures of this era (prior 1970) in the United States, will be developed, herein, using that section of Long Island not of New York City (except for the Far Rockaway area of Queens). This area coincides with the area served by the Long Island Lighting Company (LILCO), for which there is considerable statistical data available; essentially, the United States Bureau of Labor Statistics Nassau-Suffolk reporting area.[1]

INCINERATION TECHNOLOGY - PRIOR 1970

In the 1960's, the incineration of solid wastes was being developed into a fairly sophisticated technology. The concepts being introduced included:

a. Continuously fed furnaces were replacing batch fed furnaces.
b. Systems for controlling combustion air at the grates, in the ignition chamber, and in the combustion chamber... were evolving.
c. Equipment effectuating complete combustion and removing particulate from the flue-gases were being installed (electrostatic precipitators).
d. Six major companies who were supplying grate systems/furnaces, all of whom were active in further development/improvement of their systems.
e. The American Society of Mechanical Engineers established a section,"The Incineration Committee" later to be made a division, until through mesne titles, it is referred to today as the "ASME WASTE PROCESSING DIVISION"). This division started to set standards for destructive distillations of solid wastes, write codes for operation, and develop courses/manuals for "Incinerator Operations" and later "Incinerator Maintenance."
f. As a result of the ASME (see 5 above) the first criteria for flue gas (air) and ground-water pollution control were established in the 1960's; and, more important, functional requirements for these controls were developed.
g. The first real effective measure for flue gas (air) control and quench water (waste water) control were being field tested on operating incinerators.
h. <u>It is interesting to note:</u> Several systems for energy recovery were developed and actually installed on large municipal incinerators (Town of Hempstead and Town of Oyster Bay). These systems worked well, but their use was discontined because they were not economically feasible. The extra cost for the operation and maintenance could not be justified, when electric power was being generated from $0.06 per gallon fuels in very efficient power plants. Only when the cost of utility fuels exceeded ten times that amount did energy recovery from solid waste (a clean fuel) became attractive.

The history of incineration in the United States for this period is well chronicled in the "Proceedings" of the Incinerator Conferences of the American Society of Mechanical Engineers (ASME) of 1964, 1966, 1968, 1970, and 1972[2] Basically, all the major cities and suburban areas had either built or were under contract to build large incinerators. The typical plants were 500 tons per day (TPD) usually with two or more processing lines of 150, 200, or 250 TPD with a common tipping area and a common stack; many disposal facilities consisted of two 500 TPD plants. In the larger cities (typically New York, Chicago, Philadelphia) even larger furnaces and plants were built. Each new plant, usually employed the latest technology with the generation cycle at roughly five-years, and furnace replacement scheduled in on approximately 20-year cycle. The natural evolution of incinerator technology was in place.

It was during that period that the public was awakening to the environmental concerns resulting from energy conversions. However, the operators, designers, and manufacturers of incineration plants were already working on these environmental problems and several techniques for flue-gas cleansing and waste water recycling were being tested at new and existing incinerator plants. These environmental programs included:

i. Electrostatic precipitators for removing particulate in flue-gas.
j. Scrubbers for removing particulate in flue-gas and for partially absorbing certain of the undesirable gas products such as SO2 and NOx's.
k. Setting ponds and filter systems which would permit the recycling of flue-gas contaminates water (acetic) and ash quenching water (basic).
l. Analyses of incinerator residue to establish standards for contaminates such as heavy metals and hazardous non-metallic compounds.
m. Studies of air dispersion patterns from stack emissions of flue-gases.

These industry wide programs of voluntary, industry-supported development and research was aborted circa 1970, upon the introduction of Federal Government regulations/controls. In developing these new regulations, and later controls, the draftsmen almost completely ignored the wealth of knowledge and experience already accumulated. This literally short-circuited all the private sector efforts. These newly ordained "experts" began programs of enforcement by federal, state, and local governmental regulating authorities newly created for this purpose. The result was devastating; and,is discussed further herinafter.

EMBRACING ENVIRONMENTAL REGULATION 1970 TO 1990

Once the Environmental Protection Agency was created and began trying to get a handle in environmental concerns, the programs for processing, and improving upon the processing, of solid wastes suffered greatly. Unfortunately, the original appointees (many of whom were attorneys and/or not technically trained professionals) to the higher positions in of these new regulatory agencies were almost completely unknowledgeable in environmental considerations; and, lacked the experience in setting-up standards and organizing for the regulation of same. This was disastrous to the solid waste processing industry. Segments of the environmental problems were regulated without regards to the overall environmental impacts. The Air Quality Act of 1971 epitomizes this. Standards were promulgated for air quality which were arbitrarily applied and thus adversely impacted the overall environmental quality. They were standards for which neither time for enforcement or even need for same was properly addressed.

One of the reasons for enforcing the air quality of incinerators had such high priority is that incinerators had no constituency while the total adverse effect of solid waste burning was probably less than two percent (and that adverse effect was particulate which is admittedly undesirable by not an noxious as the sulfates, nitrates, chlorocarbons, etc. of the other polluters). Regulations were enforced that had the effect of systematically closing down all incinerators, because of the (then considered) excessive costs of installing (as yet unproven) air pollution control equipage.

As a result of these actions of the regulatorys, not only were operating incinerators closed, but the several companies developing incinerator technology and building incinerators went out of the business and most of the scientists, engineers, and technologists turned to other fields of endeavor. This was unfortunate because the real causes of air quality diminuation in 1970 were:

Automobile	62%
Industry	17%
Utilities	16%
All other*	5%
*(Including incinerators)	(±2%)
Total	100%

A whole new group took over the solid waste processing industry. Engineers were replaced by attorneys and financial consultants as the solving of the solid waste problem was explored by many entities including: the giants of American industry, financiers supporting (suggested but untested) technologies, and federal and state grants to test new technologies. During this period, these newly ordained experts suddenly discovered "Resource Recovery" (just as other name for incineration) and a series of pilgrimages were made to study "European technology." Actually, "European technology" was nothing more that than advances on the same 1960's technology the development of which had not been interrupted by the actions of regulating authorities. As a result of this, several European countries have transferred their technology to the United States as part of their corporate structure, in partnership with or by license to United States companies.

The European countries did have an advantage in that the resource recovery (hot-water or steam) technology was much further developed in Europe. This was largely because of the relatively high cost of fossil fuel (particularly oil) in Europe, which was anywhere from five to ten times the cost American utilities were paying for low grade fuels.

While the incineration industry was completely disrupted by regulation commencing circa 1970, there were several developments which inure to the overall improvement of the technology particularly with respect to public awareness, establishment of true values, and pre-processing standards such as source separation, mandated soft-drink containers deposits, and recycling systems all of which have made possible:

n. A significant reduction in the non-combustibles in the waste-stream, thereby decreasing the bulk handled during processing and reducing significantly the volume and weight of the (contaminated) residue by approximately 10%.
o. The separation of yard wastes remain both surface and combined waters and reduces the heterogenous nature of the solid waste stream making it easier to process.
p. The reduction in non-combustibles as increases in the heat value per pound (not the overall heat values) of the waste stream up to 20%.
q. The collecting, storing, and forwarding of solid waste in disposable plastic bags reduces significantly the amount of surface water contaminating the waste stream. When equal parts of water (by weight) are added to the solid waste stream, the result is a significant reduction in the net heating value:

The Effect of Water in Solid Waste Combustion

72 degrees F to 212 degrees F	-150 BTU/lb
212 degrees F (water) to 212 degrees F (steam)	-970 BTU/lb
212 degrees F (steam) to 2,212 degrees F (superheat)	-1,000 BTU/lb
Total	-2,020 BTU/lb

1 lb solid waste	5,000 BTU/lb
1 lb water	-2,020 BTU/lb
Net heating value/lb	2,980 BTU/lb

Regulation, education, and economics have significantly altered the factors for evaluating solid waste as a viable fuel. The remaining waste after this separation of rubble and yard wastes and the recycling of paper, plastics, glass, metal containers and certain hazardous fuel is Source Separated Refuse Derived Fuel SSRDF (not to be confused with the RDF product of mechanically processed solid waste streams). The SSRDF has there main components:

Waste Stream Analyses - Abstracted from Town of Oyster Bay Solid Waste Management Plan - November 1990 by Cashin Associates P.C. (Corrected for rubble removal)[3]

Products (Combined)	Pre-Recycle 1984	Post-Recycle 1990
Papers	41.4	42.5
Glass	6.5	3.0
Metals	5.7	6.3
Plastics	8.0	8.0
Rubber	0.3	0.3
Textiles	1.7	3.6
Wood	5.4	8.5
Food	9.3	4.7
Yard	13.8	10.5
Inorganic	4.3	5.3
Miscellaneous	3.6	1.6
	100.0	100.0

This SSRDF has a calculated heat value of approximate 5,000 BTU's per pound plus or minus 10%, which compares with other non-renewal fuels as follows:

TYPE OF FUEL[4]	HEATING BTU/lb	VALUE Therms/Ton	Equivalent Bulk Unit
Natural Gas	22,000	440	41.08 MCF
Fuel Oil NO2	19,430	389	6.61 BBL
Fuel Oil NO6	18,300	366	6.10 BBL
Coal	15,500	308	1 TON
Coal	13,000	260	1 TON
Coke	11,670	233	1 TON
Pulp	6,700	134	1 TON
Begasse	4,000	80	1 TON
SSRDF	5,000	100	1 TON
Paper/Cardboard	6,500	130	1 TON
Plastic-Average	16,000	320	1 TON

RESOURCE RECOVERY TECHNOLOGY AFTER 1990

In order to bring into focus the potential energy available in solid waste, a comparison of the renewable energies shows:

Solar Energy Annually Available To The World From Reusable Sources[5]

SOURCE	BILLIONS OF THERMS
Solar collectors	433,000
Waterfall	9,000
Land Vegetation	1,600
Tropical Waters	500
Wind	50
Heat Pumps	50
Solid Waste (United States)	23.62
Solid Waste (Nassau/Suffolk)	0.23

All Types of Energy Sources Used By LILCO For The Year-1990[6]

Fuel Oil	1.01	56%
Natural Gas	0.36	20%
Nuclear Power	0.07	4%
Purchased	0.36	20%
Total	1.80	100%

With the above statistics, a program for energy recoverable from solid waste can be evaluated. Approximately ten percent of the total electrical energy for this designated area (LILCO) could be produced from the solid waste generated therein. Looking at this possible alternative and at the changes in conditions brought about in the twenty years (1970-1990) by the introduction of regulations and environmental consciousness has produced many benefits, which will make solid waste more feasible and more attractive as an annually renewable energy source.

In producing energy, the most important considerations are economic and environmental, which complement one another. When comparing SSRDF with the energy sources, it is most likely to replace, SSRDF has the advantage:

CONSIDERATION	ECONOMIC COST/DECA THERM	ENVIRONOMICAL Sulfur Content
Fuel Type	$	%
Fuel Oil	$2.18	1.0
Nature Gas	1.80	Trace
Nuclear Power	0.98	0
SSRDF		Trace

The costs given for alternate fuels are from LILCO and are the average 1990 costs. The nuclear power is produced by facilities in which LILCO is partner.

SSRDF has essentially no cost as the cost of disposal is eliminated, if the SSRDF is used as a fuel for energy conversion. However, the costs of set conversion are higher that the costs for an equivalent amount of other fuels generated in the larger more efficient utility power plants.

THE FUTURE OF RESOURCE CONTROL - CIRCA 2000

As a result of the factors mentioned above, between 1970 and 1990, the control of solid waste processing has shifted in part from the ultimate disposer (landfill manager/incinerator plant operator) to the consumer, who has been taking more and more responsibilities for recycling.

As the environmental consciousness continues to evolve and the general knowledge of the puolic increases, the control of solid waste processing will gradually shift to the generators. A series of controls are being enacted, considered, and/or planned by Federal/State Agencies to:

t. Further expand beverage container control to all parts the country.
u. Reduce or eliminate undesirable compounds from packaging and expendable products (Florocarbons, etc.).
v. Require more reusable containers for consumer product delivery.
w. Reduce excess packaging; particularly, when the solid packaging is several times the bulk of the product delivered.
x. Require disposable products and packaging, when not readily biodegradable to be safety reducible by combustion.
y. Provide recycling systems for hazardous consumabiles (chemicals, batteries, oil wastes, etc).
z. Containers for liquids will be regulated as to size, shape, type of label, and all types of materials used.

The solid waste problem will never be completely resolved, but slowly over the next twenty year (by 2010), the waste stream in the country will be controlled by the cooperation of the producers, consumers, and disposers.

SUMMARY

If the experiences of the past twenty years are carefully reviewed, a program for solving the ecological exposures in processing our waste stream can be resolved, unfortunately, in recent years, well intented environmentalists, supported by opportunist politicians, have skewed the public's understanding of this environmental problem.

For the past several years the public has been exposed to perceptions, not facts. It is time for the technologically trained scientists, engineers, and educators to speak out on all the environmental issues and put these issues in their proper prospective.

FOOTNOTES

1The Long Island Lighting Company's (LILCO) operating area essentially coincides with the United States Bureau of Labor Statistics reporting area of Nassau and Suffolk Counties in New York State. This area has a diverse nature with a population of 2.3 million, which is approximately one percent of the population of the United States. This area is uniquely situated on an island surrounded by water on three sides and New York City to the west. This assures control of the solid waste steam, which is impacted neither by the importation of foreign wastes, nor the export of locally generated wastes, except as part of controlled disposal programs of local municipalities).

2The American Society of Mechanical Engineers (ASME) commenced holding biennial conferences in 1964, all of which have been published in these "Proceedings", which are available in local technical libraries or the Engineering Library of the Engineering Building 345 East 47th Street, New York, NY 10011; or, may be purchased (not all years available) from ASME, 345 East 47th Street, New York, NY 10011. These proceedings are chronology of the then state-of-the-art, the operating data, and program for research and development...of the Incinerator/Waste Processing Industry.

3The Town of Oyster Bay Solid Waste Management Plan - November 1990 by Cashin Associates P.C., 255 Executive Drive, Plainview, New York 11803. Contains a summary of a series of solid waste analyses made by CASHIN ASSOCIATES P.C. from which these data were abstracted.

4Steam/its generation and use-Babcock & Wilcox, 161 East 42nd Street, New York, NY 10017.

5Energy Sources - The Wealth of the World, Ayres and Scarlott - Mc Graw-Hill, 1221 Avenue Americas, New York, NY 10027.

6Long Island Lighting Company - 1990 - Annual Report and supporting documents. LILCO, 175 Old Country Road, Hicksville, NY 11801.